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CHEMISTRY WITHIN THE ATOM¹

By Dr. S. C. LIND

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IN our present age we have become accustomed to a continual acceleration in the development of all phases of human activity. A "Blitzkrieg" in international affairs is but one of the many manifestations of this acceleration.

In the realm of science, particularly in that of chemistry and physics, the rate of development has been no less phenomenal. It is not my purpose to discuss whether there is a direct relation between the two, or to try to determine what effect the advances of science have on our economic, social and political life, but rather to invite your attention to a portion of science which is so far removed from the world surrounding it that it has almost, though not wholly, escaped the

attention of those who make wars. Its only applications to human affairs have been beneficent ones. You may well wonder what branch of science has enjoyed such isolation that it could not be twisted or abused to render disservice to mankind instead of service. You may be surprised that this oasis is at the heart of chemistry far inside the atom.

Paradoxical as it may seem, a half century ago, the inside of the atom was more unknown to us than the distant stars. I suppose the antithesis of a vacuum would be absolute solidity of matter. Such the atom was supposed to be. We know now how wide of the truth this conception has been found to be, but it required several years after the first messages from the interior of the atom before its structure began to be revealed.

¹ Address of the president of the American Chemical Society, given at the centenary meeting, Detroit, Michigan, September 10, 1940.

It is not yet a half century since the first signals from far inside the atom were detected by Roentgen in the form of x-rays. Though the analogy is by no means perfect, one might say that they were the echo from the bombardment of inner electrons by electrons in electrical discharge in the form of cathode rays. The use of this terminology anticipates the actual discovery of the electron by J. J. Thomson which did not occur until two years later. And of course it was several more years before x-rays were identified as electro-magnetic pulses of short wave-length.

It was in 1896, the year between the discovery of x-rays and of the electron, that Becquerel discovered the first spontaneous messages from within the atom, spontaneous in the sense that they came without any external stimulation and had been coming undetected throughout the ages. Their emission is at the expense of the internal energy of the atom, which must be enormously great, both qualitatively and quantitatively. To this I shall refer again.

The spontaneous emission of energy from atoms takes three forms, the one like x-rays (γ -rays) another in the form of electrons (β -rays) and the third in the form of alpha rays (helium nuclei).

In 1898 Pierre and Mme. Curie discovered and separated radium. In 1902 Rutherford and Soddy announced spontaneous atomic disintegration to be the cause of radioactivity, the emission of rays or particles being the accompaniment of the disruption.

In the next few years there followed the discovery of about forty radioactive elements belonging to three different series or families, two of them having their origin in the previously known element uranium, in which Becquerel had just detected radioactivity, and the other from thorium, which Mme. Curie and Schmidt had independently discovered to be radioactive. These two elements are the primordial sources of natural radioactivity on the earth. Both have very long lives; otherwise they could not have persisted through geological ages. Neither of them is yet one fourth exhausted. Potassium should also be mentioned. Although but a feeble emitter of atomic energy, its great abundance in the earth's crust makes it an equally important geophysical source of energy.

The existence of the three radioactive series, each with a dozen or more successive genetically dependent members, is met only among the heavier atomic species. Although artificial radioactive species are now far more numerous throughout the entire range of atoms, heavy and light, the existence of genetic chains of any length is limited to the three natural series.

In 1912 Rutherford conceived the existence of the nucleus of the atom. It is quite impossible to overestimate the fundamental and far-reaching importance of this conception. It at once led to the Bohr hypothesis of electronic orbits and energy levels which af-

forded the key to spectroscopy. Only the neutron, found in 1932 by Chadwick, was needed to complete the picture of isotopes and the general ideas of atomic and nuclear structure.

But long before this in 1919 Rutherford had disrupted the nucleus artificially by alpha particle bombardment. This demonstrated that the nucleus could be attacked successfully from the outside as well as disrupted by its own internal forces.

But this artificial disruption still had to employ as its agent alpha particles from natural radioactive sources. It also lacked the most important characteristic of radioactivity. Its reactions were immediate. As soon as the bombarding agent penetrated the nucleus, disruption ensued without forming any intermediate product of definite life span. And this was found to be true although it was known that the alpha particle not only entered the nucleus but was permanently captured by it.

In 1933 Cockcroft and Walton, working in Rutherford's laboratory in Cambridge, made the atomic disruption completely artificial by employing, instead of the alpha particle from a natural radioactive source, the nucleus of the hydrogen atom or the proton, accelerated in a high voltage field obtained by the use of electrical transformers. This was soon followed by the invention of much more powerful and more convenient means of obtaining high fields—the cyclotron of Lawrence and the electrostatic generator of Van de Graaff. Also new projectiles were available in Urey's deuteron and the artificial alpha particles or helium nuclei. And as a by-product of certain bombardments or of some of the artificial radioactive reactions Chadwick's neutron was found by Fermi to be capable of entering any nucleus no matter how large or how great the nuclear charge. This possibility of course comes from the fact that the neutron having no electrical charge is not repelled on approaching a nucleus with positive charge proportional to its atomic number or the number of protons contained.

In 1934 artificial radioactivity was discovered by P. Curie and F. Joliot. In the bombardment of certain light nuclei by alpha particles they discovered intermediate products which continued to emit particles after removal from the source of bombardment. This was true artificial radioactivity for the first time.

The application of other bombarding agents—the proton, the deuteron, the slow neutron, the helium nucleus—soon followed with astonishingly fruitful results. More than seven hundred nuclear transformations have been brought about in practically all the atomic species. Nearly half of these nuclear reactions have produced new radioactive isotopes. About 20 classes of reactions have been established, based on the character of the projectile used and the type of the subsequent emission of particles and energy.

The new artificial radioactive atoms, like the older ones, undergo transmutation, accompanied by the emission of some kind of particle with or without a simultaneous emission of gamma radiation, into a stable isotope of a neighboring element. The lack of chain or series activity has already been mentioned. A greater variety of particle emissions is observed than in natural radioactivity: protons, positrons, deuterons and neutrons in addition to the alpha, beta and gamma emissions from the natural radioactive elements. In addition, the gamma radiation exhibits a much wider range of energy.

It is not too much to say that these reactions within the atoms, in the nucleus, present a wholly new field of chemistry. In the short space of five years ten times more artificial radioactive species have been produced and identified than we previously had of the natural kind, and this in spite of the fact that we have not had good means of detecting either the very short-lived or the very long-lived species like those which exist in nature. Of course the absence of other long-lived radioactive atoms in nature itself indicates that there are no others in any abundance with lives longer than the age of the earth, else they would, if existent, have survived and been discovered.

In this connection it is interesting to observe that nearly all the new artificial isotopes have sources that fit into the missing mass numbers among the known stable isotopes of any given atom. This is assuming that only one isotope of the same mass can have any existence in time. Or in other words, there can be only one stable nuclear structure made up of a given number of protons and of neutrons. While this rule that there can be no nuclear isomers is quite general, there are some definite exceptions which are becoming more numerous.

When one speaks of the atomic mass of any isotopic species of an artificial radioactive element, it is not implied that enough of any such element has been produced to measure the atomic mass by any means—not even by means of the mass spectrograph. The atomic mass of these new rare species is therefore a matter of deduction from a number of applicable principles, one of the most useful of which is the Einstein equation for the conversion of mass to energy or *vice versa*.

The relative atomic weights that are determined by the mass energy balance of Einstein represent by far the most refined atomic measurements that we possess. Their continued extension from the fourth to the fifth and sixth decimal places is no longer a matter of surprise.

When such a large quantity of energy is equivalent to so small an amount of mass as represented in the Einstein equation the determination of the energy

even crudely suffices to give relative masses with extraordinary accuracy.

In all the nuclear reactions of atomic disruptions that we have discussed so far or that were known up to the beginning of 1939, the change in the nucleus was accompanied by the emission of particles of small mass, as electrons, a positron, a proton or a neutron; and only one of these for each atom disrupted. The alpha particle was the heaviest particle known to be emitted from the nucleus. In fact the amount of energy necessary for the ejection of a heavy particle from the nucleus would have been regarded as impossibly high.

Apparently no one had seriously considered the possibility that the nucleus might be split into two more or less equal parts; but that is exactly the interpretation of the reactions which certain uranium or thorium atoms undergo when the nucleus is entered by a neutron of slow speed.

In his studies of the action of neutrons on atoms of high atomic weight, Fermi had discovered that uranium atoms, as well as those of thorium, show exceptional behavior after their nuclei are pierced by slow neutrons, in that they exhibit radioactive properties accompanied by or consisting of a multiple emission of neutrons with extremely high velocity—three of the high-speed ones for one initial slow one. This represents a great gain or multiplication of energy at the expense of the intra-atomic energy. In addition there was a successive emission of electrons or beta particles.

It was at first thought that these phenomena could be interpreted as the production of a series of transuranian elements with atomic numbers 93, 94, 95, 96 and 97. Subsequently Hahn and Strassmann found that the new elements were not transuranian but were new radioactive isotopes of atomic number a little more and correspondingly a little less than half the original atomic number of uranium.

In these reactions the multiple emission of neutrons and the successive emissions of electrons both are understood if one recalls the ratio of neutrons to protons in normal atoms as a function of their atomic number or mass. In the light atoms the ratio is unity, one neutron for each proton as evidenced by the atomic mass being just twice the atomic number for the light atoms. With increasing atomic mass the ratio of neutrons to protons increases steadily and reaches the value 1.6 for heavy atoms like uranium. If then a heavy atom could be split into two nearly equal parts, each part would have a large excess of neutrons over protons and hence a tendency to get rid of neutrons. This can be done in two ways: either by their ejection from the nucleus, hence their multiple emission; or by their conversion into protons

with liberation of electrons, hence the successive beta ray emissions. The result of the bombardment of uranium by slow-speed neutrons is the splitting of the atom, termed *fission*, with the production of some new radioactive elements about midway in the periodic system, and the liberation of an astonishingly high amount of energy.

It is the latter which has recently attracted attention as a possible source of intra-atomic energy that might be utilized as a practical source of power.

The multiplication of neutrons was found to be in the ratio of three emitted for one absorbed. Evidently if this should be continued into a chain process of any length the multiplication of energy liberated would lead to explosive reaction. It was even feared, under the supposition that ordinary atoms of U^{238} were responsible for the reaction, that it would be dangerous to have a large amount of pure uranium collected at one time and one place. This supposition could be set aside, however, in the light of the experience of the U. S. Bureau of Mines which at one time had and kept in Colorado for some years several tons of 100 per cent. uranium oxide without any unusual consequences.

The question then became whether one of the rarer isotopes of uranium might not be responsible for the behavior just discussed. Besides U^{238} , the common isotope of uranium, there are two others, U^{235} , long known as the head of actinium series which occurs in the proportion 1 U^{235} to 139 U^{238} ; and U^{234} known in the uranium family as U_{II} , the immediate parent of ionium, with an abundance of 1 U^{234} to about 450 U^{238} or about 3 per cent. of the number of U^{235} atoms.

By a very skilful mass spectrographic separation of the gaseous ions of uranium tetrabromide, Nier obtained enough material to show in collaboration with Booth, Dunning and Grosse that it is the isotope U^{235} that is responsible for the remarkable multiplication of neutron emissions and of energy.

This discovery has led to much speculation as to the possibility of utilizing this material as a large source of power. Two questions arise. Is there enough of it and can it be obtained in a state of purity suitable for the proposed uses?

The first question can be answered readily in the affirmative. A very modest estimate of the radium production per year would be 10 grams of the element. Associated with this in nature is about 80,000 pounds of uranium. Of this, 1/139 part of 570 pounds would represent U^{235} . Since it is estimated that only five pounds would suffice for a very considerable power production, it is evident that the natural source is large enough to be very important.

The second question is: Can the isotope be separated from U^{238} ? This is a problem to which the an-

swer may not be so soon found. It seems agreed that the mass spectroscopic method used for separation in minimal quantities will not be applicable for such amounts as would be useful in power production. Only experimentation can show whether some other method may not be efficacious. It would be hazardous to predict that at some time in the future one or another method may not succeed.

One other question still might be pertinent: Admitting that it may be possible to obtain isotope U^{235} in quantities and at costs that make it available for practical power production, is it certain that the calculated amount of energy will be delivered and that it can be suitably controlled? The answer to this is necessarily highly speculative. The entire field is new. The methods of measurement, however, appear to be reliable and there seems to be no doubt of the energy emission when U^{235} is bombarded by slow-speed neutrons. This very fact, that it is the slow-speed ones which are effective in setting off the reaction but that high-speed neutrons are ejected, simplifies the control, at least theoretically. The presence of water slows down the high-speed neutrons so that the reaction becomes continuous and the excess energy absorbed by water is rendered available through its mediation. By withdrawal of the water the reaction is retarded or stopped. This seems simple enough for adequate control, but what practical difficulties may intervene in large-scale operation if and when we have pounds of pure U^{235} remains to be seen.

But whether or not the nucleus of the atom ever becomes an available source of intra-atomic energy, it has already furnished us one of the most interesting chapters of chemical science. A finer illustration of man's persistence and perspicacity can scarcely be found. The challenge of the atom has been met, the impenetrability of the nucleus has been conquered.

That these triumphs extend far beyond the bounds of chemistry and physics is well known to you all. The new elements are used as tracer elements in the fields of biology, botany, medicine and genetics. Even the age and energy of both the earth and sun are no longer mysteries.

But of greatest importance to the chemist is the new knowledge of atoms of different elements and their relation to each other. Prout's hypothesis has been more than justified. The Periodic System has been elucidated and extended. The nature of isotopes is no longer a mystery; even progress in their separation is being made.

It is well to keep in mind, however, that reactions resulting from bombardment occur in infinitesimally small amounts. A very small target is being shot at. Most of the projectiles fly wide of the mark. The neutron, however, has new and astounding properties

of great promise. It must, however, be obtained through some nuclear reaction of bombardment with all the attendant inefficiency.

These difficulties, however, challenge but do not

discourage the scientist. When he has once found the way to the nucleus, the heart of the atom, he will never give up until this new field of chemistry is in complete surrender to the scientific "Blitzkrieg."

OBITUARY

RAYMOND SMITH DUGAN

THE death of Raymond Smith Dugan on August 31 deprives American astronomy of one of its best observers.

Born at Montague, Mass., on May 30, 1878, he was of Irish descent through his paternal grandfather, and from his mother received a Puritan inheritance going back to Myles Standish. His early training was characteristic of the New England village in which he lived, and led naturally to Amherst College, where he received his A.B. in 1899. Three years followed as instructor in mathematics and astronomy at the Syrian Protestant College at Beirut, and three more at Heidelberg with Max Wolf—where he discovered a considerable number of asteroids, including (508) *Princeton*, (516) *Amherstia* and (535) *Montague*, and received his Ph.D. in 1905. Returning to America, he was appointed instructor in astronomy at Princeton, beginning an association of thirty-five years with that university, and with the writer.

The 23-inch equatorial and polarizing photometer of the observatory offered a field of research then new to him, in which he soon became a recognized authority, and continued active for his whole career. Realizing that precise observations are most valuable in cases which are capable of detailed discussion, he specialized on eclipsing variables, seeking to secure highly accurate light-curves for a few stars rather than provisional results for many. This involved great labor—for Z Draconis 1149 sets of 16 readings each—but the soundness of his judgment has been shown by the wealth of information regarding the dimensions, densities, forms, and even the internal constitution, of the stars which can thus be obtained.

Observations of such stars are a lifelong task, for many of them show slow changes in period, most of which are as yet unexplained, and unpredictable, and have to be followed year by year.

The discussion of his observations was made with equal thoroughness, making his monographs excellent reading for the student.

He was the first to detect the brightening of the faint companion on the side heated by the radiation of the primary—generally known as the "reflection effect."

His work was recognized by his advancement to the professorship at Princeton which he held for twenty years, by election to the American Philosophical Society, and as chairman of the Commission on Variable

Stars of the International Astronomical Union. He was an active member of the American Astronomical Society and served as its secretary from 1927 till 1936 and vice-president from 1936 till 1938, to the great satisfaction of its members. In this position, and on the many occasions when he was acting director of the observatory at Princeton during the writer's absence, he showed excellent judgment, executive capacity and diplomatic skill.

He was a good teacher, especially of graduate students. A long series of these inspired by him shared in the photometric observations. In 1937, when he took account of the record, these had made more than 200,000 photometric settings and he himself 300,000.

He bore an important part in the preparation and revision of the text-book on astronomy, in which J. Q. Stewart and the writer shared.

No account of him would be complete without reference to his humor—a combination of Irish wit and dry Yankee shrewdness of expression—which crops out again and again in his reports as secretary and in his whimsical account of work in the old dome at Princeton,¹ which will rouse sympathetic chuckles from those who have never worked with what a student on examination once called a "refractory telescope" and deep memories in those who know the old place.

Shortly after the modern and convenient equipment of the new observatory became available he began to suffer from arthritis, which soon put an end to night work. He bore the physical suffering which followed with unbroken courage and the dry humor characteristic of him. Till within a few months, he continued active research, reducing his accumulated observations and working upon variations in period of eclipsing stars, with the aid of photographic data generously supplied from Harvard. The continued strain of his illness proved too much for his constitution, and the end came.

His widow, a sister and two adopted children survive him.

The writer can not close without an expression of his personal regret at the loss of a colleague with whom in the course of these many years there has never been any occasion of serious difference.

HENRY NORRIS RUSSELL

¹ *Popular Astronomy*, 43: 146, 1935.

RECENT DEATHS

DR. HANS ZINSSER, professor of bacteriology at the Harvard Medical School, died on September 4 in his sixty-second year.

DR. PHOEBUS AARON THEODORE LEVENE, member of the Rockefeller Institute for Medical Research from 1907 to 1939, died on September 6 at the age of seventy-one years.

DR. FREDERICK PATTISON WEAVER, since 1925 pro-

fessor of agricultural economics at the Pennsylvania State College, died on September 5 in his sixty-eighth year.

DR. MAUDE E. S. ABBOTT, assistant professor of medicine at McGill University, died on September 2 at the age of seventy-one years.

WILLIAM LASH MILLER, head of the department of chemistry, University of Toronto, died on September 1 at the age of seventy-three years.

SCIENTIFIC EVENTS

THE HALL OF ETHNOLOGY OF THE MUSEUM OF NEW MEXICO

THE Museum of New Mexico, Santa Fe, has been given, according to *Museum News*, the old Santa Fe Armory, adjoining the Palace of the Governors on Washington Avenue, and is remodeling it for use as a hall of ethnology. The property was assigned to the museum by act of the State Legislature, which also appropriated \$10,000 for remodeling. The WPA is supplying the labor. Plans for remodeling, in the Pueblo style, were drawn by John Gaw Meem. The entire structure will be given over to ethnology. The entrance hall, 20 by 55 feet, will be arranged as a hall of man, with a series of life-size busts showing the evolution of the human race and a series of racial group busts, supplemented by an evolutionary series of implements and tools. The main exhibit hall, 50 by 75 feet and containing 3,750 square feet of exhibition space, will illustrate the living Indians of the Southwest and their cultural attainments. Through the center will be a series of models of Indian dwelling types and a kiva, with appropriate native life. Around three sides of the hall alcoves will contain exhibits of silversmithing and turquoise work, weaving, basketry, leather and bead work, ceremonial items, paintings, pottery, grinding and native economy and a typical pueblo room. Wall cases forming the alcove boundaries will carry charts, diagrams and photographs. In the alcoves Indians will carry out the pursuits of the alcove themes, a few at a time, for the double purpose of encouraging the Indians and showing visitors how things are actually done. A small room off this large hall will be used for special rotating exhibits of comparative material from the Americas. The second floor space will be used for the curator's office, private laboratory, office for assistants in the department, laboratory of physical anthropology and rest room. The full basement will contain a fireproof vault, dustproof storage for ceramic collections, two dustproof storage rooms for basketry and miscellaneous material, temporary storage for skeletal material from excavations, preparator's laboratory, janitor's room and public rest rooms.

Out-of-doors at the back of the building will be a small placita with a modern Pueblo oven for baking bread and space for a pottery-firing kiln. Miss Bertha Dutton has been appointed curator in charge of the newly established department of ethnology.

GOVERNMENT POSITIONS UNDER THE CIVIL SERVICE COMMISSION

APPLICATIONS must be on file by September 16 with the United States Civil Service Commission at Washington, D. C., for the position of assistant curator of ethnology in the National Museum, Smithsonian Institution, at a salary of \$3,200 a year. An existing vacancy in this position in Washington and future vacancies in positions requiring similar qualifications will be filled from this examination, unless it is found in the interest of the service to fill any vacancy by reinstatement, transfer or promotion.

An examination to secure specialists in conference planning for the Office of Education is also announced. The salary is \$4,600 a year. Applicants must have completed a 4-year college course and must have had administrative experience or highly responsible experience in organization work. In addition, they must have had experience in planning and conducting formal conferences, forums or other group activities for the purpose of discussion of public affairs. Writing experience in the field of education of adults in public affairs is also necessary. Examinations to secure personnel technicians for Government service cover the following grades: Personnel technician (test and measurements), \$3,800 a year; also senior, \$4,600 a year; associate, \$3,200 a year; assistant, \$2,600 a year, and junior, \$2,000 a year.

Examinations are also announced covering two grades in naval architecture and marine engineering, as follows: Principal, \$5,600 a year; senior, \$4,600 a year. Applications may be filed until June 30, 1941. Qualified persons are urged to apply at once. Examinations for lower-grade naval architect and marine engineering positions were announced in June and the commission still is accepting applications for these positions.

Salaries in all cases are subject to a retiring reduction of three and one half per cent.

WORK OF THE NEW YORK UNIVERSITY COLLEGE OF ENGINEERING

SIXTEEN experts from the food and chemical industries will join with the faculty of the Graduate Division of the New York University College of Engineering this autumn in offering a new course in food engineering, which is one of the seventeen new courses to be given during the coming academic year.

According to Dr. Henry J. Masson, director of the Graduate Division and chairman of the department of chemical engineering, these courses will be conducted in the departments of administrative, chemical, civil, electrical and mechanical engineering and in the department of meteorology.

They are designed principally in accordance with the expressed needs of men employed in industrial and governmental work. The bulk of all graduate instruction at the college is offered in the evenings and on Saturdays, and combines advanced study with the practical experience and knowledge gained as a result of day-time occupations.

The course in food technology was developed after consultation with leading food technologists, many of whom will assist in teaching the course. It was based upon the concept of unit operations as developed by the chemical engineer, modified and adapted to the food industry. Lectures by industrial specialists will cover such topics as pasteurization, refrigeration, baking, packaging and bottling, canning, humidification and air conditioning.

Among the industrialists who will lecture during the course are: C. G. Segeler, American Gas Company; J. E. Guinane, Frosted Food Sales Corporation; C. A. Southwick, General Foods Corporation; C. O. Ball, American Can Company; Laurence V. Burton, *Food Industries*, and James A. Lee, *Chemical and Metallurgical Engineering*.

New courses in foundation engineering and soil mechanics will be offered by the department of civil engineering, in addition to other advanced courses in materials testing and model analysis. Polarized light will be employed in determining stress directions, while Beggs deformeter gages will be used on structural models.

Courses in the principles of audio-frequency, advanced radio-frequency and fundamentals of power system analysis will be added by the department of electrical engineering. The mechanical engineering department will add a course dealing with centrifugal pumps and compressors, while the department of meteorology will offer a new course in maritime meteorology and oceanography. Two new courses will be added by the department of administrative engineering covering production control and statistics. In

addition to the course in food engineering the chemical engineering department will also add courses in mathematics as applied to chemical engineering and diffusional processes.

In cooperation with the Westinghouse Electric and Manufacturing Company, the division will also offer new courses covering industrial marketing, applications of electrical equipment and power system relaying.

THE DETROIT ZOOLOGICAL PARK

Museum News states that expenditures for improvements and additions to the Detroit Zoological Park under Federal work programs have cost \$1,556,000 in allotments from the United States Government and \$380,000 contributed by the park commission. New structures at the park completed in this building program include the administration building, the animal service building, the animal hospital building, hippopotamus building and exhibit, ostrich house, tiger exhibit and building, North American barnyard exhibit and building, South American mammal building and barless exhibit, South American pampas and buildings, African swamp exhibit enlarged and new building, monkey island, bear den and maternity cages, animal theater, aoudad rock and moats, beaver exhibit, trout stream with reservoirs and cascade, vegetable cellar of concrete and steel, and barless enclosures for alligators, reptiles and wolverine, raccoon and wolf. A log aquarium is in process of construction. Improvements were made in the North American plains exhibit; and the structure used formerly for a skunk exhibit was rebuilt for reptiles. For the railroad that encircles the park new stations, underpasses and a comfort station were completed. In addition, the wire enclosing fences were replaced with masonry walls; and sewers, water lines, paved walks and paved service roads were built. There are new entrance gates, new landscaping including the planting of hundreds of trees and new hotbeds for the greenhouses. John T. Millen is director of the park.

THE WOODS HOLE OCEANOGRAPHIC INSTITUTION

C. O'D. ISELIN, assistant professor of oceanography at Harvard University, director of the Woods Hole Oceanographic Institution, contributes an article to *The Collecting Net*, giving an account of the eleventh annual meeting of the Board of Trustees, which was held on August 15. Besides the ordinary routine business, the trustees voted to accept the *Anton Dohrn*, a gift from the Carnegie Institution of Washington. This 70-foot power boat was formerly used at the Tortugas Laboratory in Florida and will be converted during the coming winter for work in the coastal waters off New England.

The trustees discussed the rôle of modern ocean-

ography in the movement towards increased national defense. It was agreed that the complete facilities of the institution should be offered to the National Defense Research Committee. Dr. Frank B. Jewett, a member of this committee and also a trustee of the Woods Hole Oceanographic Institution, explained how a closer cooperation between oceanographers and naval research could be achieved. While it still remains to be decided just which problems will be attacked first,

it is clear that Woods Hole will soon become one of the headquarters for investigations of importance to the national defense and only rather remotely connected with oceanography in its ordinary sense. The retiring class of trustees was reappointed. These included Henry B. Bigelow, William Bowie, A. G. Huntsman, Alfred C. Redfield, Henry L. Shattuck and T. Wayland Vaughan. Dr. Vannevar Bush was elected a member of the corporation.

SCIENTIFIC NOTES AND NEWS

THE Leidy Medal of the Academy of Natural Sciences of Philadelphia has been awarded to Dr. Merritt L. Fernald, since 1915 Fisher professor of natural history at Harvard University and director of the Gray Herbarium. The medal is awarded in recognition of "outstanding contributions to the floristics of the eastern part of North America, including the Maritime Provinces and the Coastal Plain Region of the southern United States, and his correlations of the present-day distribution of plant life in North America with geologic history." The medal will be presented at a reception at the academy on September 17 by Dr. William B. Scott, emeritus professor of geology and paleontology of Princeton University.

THE University of Pennsylvania will confer twenty-one honorary degrees on September 21, when the Bicentennial Celebration Week will be brought to a close at a convocation in Convention Hall. Seven of the degrees will be conferred *in absentia* on European scholars who, although they will contribute papers to be read at a Bicentennial Conference during the celebration, will be unable to attend because of the war. Degrees conferred on scientific men are the doctorate of science on William M. Clark, director of the department of physiological chemistry, the Johns Hopkins University; Evarts A. Graham, Bixby professor of surgery, the School of Medicine, Washington University, St. Louis; Frank B. Jewett, president of the Bell Telephone Laboratories and president of the National Academy of Sciences; Wesley C. Mitchell, professor of economics, Columbia University; Charles S. Myers, formerly director of the Laboratory of Psychology, University of Cambridge (*in absentia*); Hermann Weyl, professor of mathematics, the Institute of Advanced Study, Princeton, N. J. The doctorate of laws will be conferred on Lawrence J. Henderson, professor of biological chemistry, Harvard University, and Herbert S. Jennings, professor of zoology, University of California.

DR. GEORGE BLUMER, since 1920 David P. Smith clinical professor of medicine at the Yale University School of Medicine, was guest of honor at a dinner marking his retirement from active service. Dr.

Francis G. Blake, Sterling professor of medicine, was toastmaster. The speakers included Drs. Milton C. Winternitz, dean of the School of Medicine from 1920 to 1935, and Stanhope Bayne-Jones, dean from 1935 to 1940; William F. Verdi; Fu-ching Yen, a former student of Dr. Blumer and minister of health of the Republic of China, and Dr. James R. Angell, president emeritus of the university.

DR. ROBERT O. LAMBERT, associate director for the medical sciences of the Rockefeller Foundation, New York, was on July 14 the guest of honor at a dinner in San Juan given by former associates at the School of Tropical Medicine of the University of Puerto Rico, where he was for two years professor of pathology and the first director of the school.

DR. GORDON S. FAHRNI, of Winnipeg, was chosen president-elect of the Canadian Medical Association at the recent annual meeting in Toronto. He succeeds Dr. Duncan Graham, of Toronto, who became president.

DR. WOJCIECH SWIETOSLAWSKI, professor of chemistry and head of the Physico-Chemical Institute of the University of Warsaw, formerly Minister of Education of Poland, now chairman of the Committee on Physico-Chemical Data of the International Union of Chemistry, has been visiting professor of chemistry in the University of Pittsburgh since March. He becomes this month visiting professor of chemistry at the State University of Iowa, where he will remain until February.

DR. J. RICHARD WEISSENBERG, formerly professor extraordinarius of anatomy at the University of Berlin; in 1937 visiting professor of cytology at Washington University, St. Louis, and in 1939 member of the Wistar Institute, Philadelphia, has been appointed professor of histology and embryology at the School of Medicine of Middlesex University, Waltham, Mass.

DR. BERNHARD KURRELMMEYER, associate professor in the department of physics of Brooklyn College, has been promoted to a full professorship.

DR. JOHN RINEHART, of the State University of

Iowa, has joined the staff of the department of physics at Kansas State College, Fort Hays.

DR. EDWIN B. ASTWOOD, associate in obstetrics at the Johns Hopkins University, will join the Harvard Medical School as assistant professor of pharmacotherapy. He will also be a member of the medical staff of the Peter Bent Brigham Hospital.

DR. EDGAR HULL, professor and head of the department of medicine of the Medical School of the Louisiana State University, New Orleans, has leave of absence from October 15 to May 15 of next year to accept a temporary appointment as associate professor of medicine at Yale University.

THE retirement is announced of Dr. David H. Newland, since 1927 state geologist at the New York State Museum, Albany, N. Y. Dr. Newland was assistant state geologist from 1905 until 1920, when he resigned to undertake private work in economic geology. He was appointed state geologist in 1927.

DR. G. A. ZENTMYER, JR., a member of the staff of the Bureau of Plant Industry of the U. S. Department of Agriculture at San Francisco, has been appointed research assistant in plant pathology at the Connecticut Experiment Station at Storrs. He will devote his time to investigations of the Dutch elm disease.

DR. J. WALLACE PAGE, JR., dual professor in chemistry and science education at Syracuse University, has been appointed director of the Maryland Academy of Sciences. Dr. Page organized and directed at Syracuse a center of science club activities of the American Institute of the City of New York.

DR. LOUIS B. FLEXNER, associate in anatomy in the School of Medicine of the Johns Hopkins University, has been appointed to the staff of the Carnegie Institution of Washington as research associate in the department of embryology, Baltimore. He will continue to investigate chemical interchanges in mammalian development, making use of artificially radioactive substances in cooperation with the Department of Terrestrial Magnetism of the Carnegie Institution. Dr. Herbert A. Pohl has been appointed as research assistant in the department of embryology and Dr. Alfred Gellhorn a research fellow. Dr. Inez Colombo de Allende, during the past year traveling fellow of the Argentine Association for the Advancement of Science at the University of Rochester, has been appointed to a Rockefeller traveling fellowship and will spend the year 1940-41 at the department of embryology of the Carnegie Institution.

DR. ARTHUR K. PARPART, assistant professor of physiology at Princeton University, has been appointed director of the course in physiology at the

Woods Hole Marine Biological Laboratory for 1941. He succeeds Dr. Laurence Irving, professor of biology at Swarthmore College and director of the Edward Martin Biological Laboratory.

DR. GLENN W. PARSONS, assistant professor of chemistry at the University of Mississippi, has become associated with the Chemical Division of the Procter and Gamble Company, Ivorydale, Ohio.

DR. EDWARD WIGGLESWORTH, for twenty years director of the Boston Society of Natural History, has resigned to become Eastern director of the Gemmological Institute of America and chairman of its educational advisory board. The gemmological laboratory at 69 Newbury Street, Boston, will be under his direction. This is the second gemmological laboratory of the institute, the first having been conducted in Los Angeles since 1933.

R. D. MACCART, chief engineer of the Brewster Aeronautical Corporation, has been elected vice-president of the corporation in charge of engineering.

PROFESSOR M. S. COOVER, head of the department of electrical engineering at the Iowa State College, has been appointed secretary of the division of electrical engineering of the Society for the Promotion of Engineering Education and also a director of the American Institute of Electrical Engineers.

A RESEARCH grant has been extended by the Committee on Scientific Research of the American Medical Association in aid of the researches of Professor Chas. W. Greene on the coordinations of the coronary circulation. These investigations are being carried out in the physiological laboratories of Stanford University.

THE department of chemistry of the University of Pittsburgh has received two grants for post-doctorate fellowships. The first from the Carnegie Institution of Washington for the study of heats of dilution has been awarded to Dr. William E. Wallace, of Mississippi College and the University of Pittsburgh, who will be associated with Dr. A. L. Robinson. The second fellowship, which is from the John and Mary R. Markle Foundation, has been awarded to Dr. Richard H. McCoy, of the University of Illinois, who will engage in biochemical research under Dr. C. G. King, professor of biochemistry.

DR. FRANKLIN G. EBAUGH, professor of psychiatry of the School of Medicine of the University of Colorado, Denver, will deliver the Rogers Memorial Lecture on September 19 on "Our Mental Health."

DR. LEWIS KNUDSON, professor of plant physiology at Cornell University, spoke on August 22 before the newly formed Puerto Rico Orchid Society on "Orchid Seed Germination"; and on August 24 he spoke before the staff of the Puerto Rico Experiment Station of the

U. S. Department of Agriculture on "Environmental Conditions Favorable for Orchid Culture."

THE dedication exercises of the Administration Building of Bellevue Hospital, New York, were held on September 11. Dr. S. S. Goldwater, commissioner of the department of hospitals, presided. The speakers were Dr. I. Ogden Woodruff, representing the Medical Board; Dr. William F. Jacobs, medical superintendent; Mrs. Henry James, president of the Board of Managers of the Bellevue School of Nursing; Colonel E. W. Clark, commissioner of public work, Federal Works Agency; Hon. Irving V. A. Huie, commissioner of the department of public works, New York, and the Hon. F. H. LaGuardia, mayor of the city.

THE New York Medical College and Flower and Fifth Avenue Hospitals will receive \$242,531, the residue of the estate of Mrs. Helen S. Case, who was the wife of the late Major James F. Case, mining engineer.

THE Rockefeller Foundation of New York City has made an appropriation to the Iowa State College of \$21,000 to be used over a period of three years for work under the direction of Professor J. W. Gowen,

of the department of genetics, on bacterial wilt of corn and mouse typhoid.

THE Illinois Institute of Technology, Chicago, has for the academic year 1940-41 received two fellowships of \$900 for graduate study established by Universal Oil Products for work in the catalytic laboratory under the direction of Dr. Vasili I. Komarewsky.

THE General Education Board, New York, has given the University of California Institute of Child Welfare a grant of \$61,700 for the continuation of studies on the mental and physical development of children.

Museum News reports that the collection of the Daniel B. Dyer Museum, which occupied four rooms in the basement of the Kansas City Public Library, has been assigned to the Kansas City Museum as a result of a decision by the circuit court. The collection was in custody of the Board of Education, which asked to be relieved of the trusteeship. The material transferred comprises American Indian, including mound builder and cliff dweller, material; Mexican and Oriental objects; Spanish-American war material; coins and medals; small fossils; minerals; glass, china and copperware.

DISCUSSION

APPARENT SPLITTING OF LIGHT FROM FLUORESCENT LAMPS BY REFLECTION FROM THIN PLATES

ATTENTION was recently directed to the apparent splitting of light from fluorescent lamps by moving objects.¹ This phenomenon was attributed to the intermittent emission of light of different wave-lengths. The latter characteristic has been described in detail by Fonda² and by Thayer³ upon the basis of the time intervals between the mercury discharge and the different periods of excitation and decay of the "phosphors" coating the tube. A qualitatively different kind of splitting of this light has been noted incidental to the use of an oscillographic device consisting of a microscope slide separated by a thin wedge of air from a glass cover slip.⁴ When pressure is applied to the thin slip the wedge is diminished in thickness so that on being viewed in ordinary white light from such sources as the sun or incandescent lamps colored interference bands or Newton's rings are seen. If the light is filtered through colored glass the interference bands are somewhat more clearly evident. When, however, the device is illuminated by light from fluorescent

lamps still greater sensitivity is secured in that lesser increments of applied pressure are required to produce the first visible bands. On close inspection a double set of bands can be recognized. One of these varies with alternations of pressure; the other remains constant. The variable pattern is produced by the changing distances between the reflecting surfaces. The fixed pattern is produced by the cover slip alone, the slide showing no separation of the light. The production of interference patterns by reflection of ordinary white light is recognized only with much thinner plates, *viz.*, of the magnitude of oil films and soap bubbles. In contrast, the comparatively thick plates, glass cover slips from approximately 0.10 mm to 0.18 mm (No. 0 to No. 2), show definite patterns in fluorescent light. The bands produced by illumination from the "Daylight" lamp are red, yellow and blue. The bands are broad and few in number with the thin slips and comparatively narrow in number with the thicker slips. When viewed from comparatively larger angles and distances, microscope slides show similar colored bands. The general contour of the patterns is comparable to that produced by reflection of light from the sodium flame. Similar phenomena are recognized with other thin materials. For example, sheets of mica exhibit colored patterns consisting of wide bands, and Cellophane reveals on close examination fine streaks of color due to the irregular thickness of the

¹ C. Wesler Scull, C. G. Grossepup and E. G. Witting, *SCIENCE*, 91: 357, April 12, 1940.

² G. R. Fonda, *SCIENCE*, 91: 476, May 17, 1940.

³ R. N. Thayer, *SCIENCE*, 91: 524, May 31, 1940.

⁴ C. Wesler Scull, *Jour. Lab. Clin. Med.*, 24: 753, April, 1939.

film. The appearance of interference colors by the comparatively thick plates in fluorescent light is due, not to the intermittent flashing, but to the discontinuity of the spectral quality of the components of the light. The latter, *viz.*, that of the mercury discharge and of the various "phosphors" have individually fairly limited spectral ranges. The patterns are comparable to those which would be produced by the mixture of a few essentially monochromatic lights. It is apparent that illumination by fluorescent lamps provides a convenient means for estimating the relative thickness and the optical regularity of the reflecting surfaces of thin plates. It is further evident that such lamps provide a readily available source of light for interferometric devices.

C. WESLER SCULL

ABINGTON MEMORIAL HOSPITAL,
ABINGTON, PA.

EXISTENCE OF ONLY ONE VARIETY OF CULTIVATED MANGOSTEEN EX- PLAINED BY ASEXUALLY FORMED "SEED"

THE luxurious flavor, beauty and texture of the fruit of the mangosteen, *Garcinia mangostana*, makes it, in the opinion of most people who know it, the best of the tropical fruits. A great deal has been published about this Asiatic species, especially concerning the difficulty which in general is attributable to poor root growth of growing plants through the juvenile stage.

Examination of the normal shriveled anthers in many flowers from two 37-year-old trees at the Puerto Rico Experiment Station of the United States Department of Agriculture has shown no pollen to be present. These female trees are reproduced through "seed" without the presence of the functional male flowers that are borne on separate trees, none of which exist in Puerto Rico. Backer¹ in 1911 stated that male flowers of the mangosteen had nowhere been found during the last hundred years. Descriptions of the male flowers that were, nevertheless, dated during that one-hundred-year period^{2,3} or more recently⁴ have been studied. Backer's description³ is admittedly based upon Roxburgh's, and that of Oehse also corresponds closely to Roxburgh's. Thus it appears that all are based upon Roxburgh's description. Whether that was made from living or herbarium specimens is not indicated. Backer's statement that male flowers had

not been found within one hundred years leads, therefore, to the assumption that Roxburgh's description was probably based upon herbarium, not living, specimens. Study of these descriptions leaves no doubt about the male flowers being distinct from the female flowers of the Puerto Rican trees.

About half of the fruits produced by these trees have well-developed "seeds," each fruit rarely having more than one. A longitudinal section of this "seed" shows a structure much different from that of the normal dicotyledonous seed. The "seed" formation in the cultivated mangosteen is asexual. Sprecher⁵ explained this freakish asexual reproduction mechanism in the mangosteen and called it apomixie. As he describes it, the adventitious embryo that develops to form the "seed" originates from a cell in the epithelium of the ovary inner integument. The reproduction is thus distinguished from nucellar budding that occurs in the apogamic reproduction in the mango and in Citrus. As the cell of the inner integument develops into a papilla and further to form the seed the nucellus and the embryo sac become nonfunctional. Similar adventitious embryony has been observed by Hegelmaier in *Allium odorum*.⁶ Sprecher called the "seed" a hypocotyl-tubercle. According to him and Pierre⁷ no traces of radicle, stem or cotyledons are present in the "seed." A similar structure has been observed at the Puerto Rico Experiment station in "seeds" of *Rheedia brasiliensis* and *R. macrophylla*.

Descriptions of mangosteen fruits from Java, Malaya, Trinidad and elsewhere conform precisely to the fruits produced in Puerto Rico. It would therefore seem that different varieties of the cultivated mangosteen do not exist. Fairchild,⁸ traveling extensively in the Tropics studying the mangosteen, has stated that there are apparently no varieties of this fruit tree; seedlings everywhere bear curiously uniform fruits. Burbidge⁹ in 1887 saw in British North Borneo what he considered a native form of the mangosteen. Fruits of this differed from those of the cultivated form, being 4-carpellate, each carpel having a well-developed seed, while in the cultivated form there are from four to eight carpels, rarely more than one or two of which develop "seed." Wester¹⁰ describes the Jolo mangosteen as being rather larger than those of Singapore and Saigon and as having a thicker rind. Its flesh, too, is more acid and has more character than the milder flavored fruit of the Malay Peninsula

⁵ M. Andreas Sprecher, *Rev. Gen. Bot.*, 31: 513-531. 1919.

⁶ F. Hagelmaier, *Bot. Zeitung*, 55: 133-140. 1897.

⁷ M. E. Pierre, *Bul. Mensual Soc. Linn. de Paris*, 1: 350. 1882.

⁸ David Fairchild, "Exploring for Plants," p. 392. New York: The Macmillan Company. 1930.

⁹ F. W. Burbidge, *Gardeners' Chronicle*, n. s., 21: 23, 1884.

¹⁰ P. J. Wester, *Philipp. Agr. Rev.*, 13: 50, 1920.

¹ C. A. Backer, "Schoolflora voor Java," p. 91. Batavia: N. V. Boekhandel en Visser and Company. 1911.

² William Roxburgh, "Flora Indica," 2: 618-620. London: Parbury, Allen and Company. 1832.

³ C. A. Backer, "Flora van Batavia," pp. 84-85. Batavia: G. Kolff and Company. 1907.

⁴ J. J. Oehse, "Fruits and Fruitculture in the Dutch East Indies," pp. 53-54. Batavia: G. Kolff and Company. 1931.

and Java. Its seeds are said to be larger. Such differences might be due to environment.

Aside from these two notes, no mention of other mangosteen variations has been found in the literature.

This unusual asexual reproduction in the cultivated mangosteen accounts for the curious uniformity in its fruits wherever grown, and this famous fruit seems to be of one variety only.

Further anatomical studies of the mangosteen flower, fruit and "seed" are being continued at the Puerto Rico Experiment Station of the U. S. Department of Agriculture.

CLAUD L. HORN

PUERTO RICO EXPERIMENT STATION
OF THE U. S. DEPARTMENT OF AGRICULTURE,
MAYAGUEZ

AND/OR OR ANDOR

THE use of the form "and/or" in legal practice is well established. In recent years I have noticed an increasing tendency for writers of scientific papers to make use of it. The question of the need for such a form of expression I do not wish to raise here, but the presence of a symbol of this kind upon the printed page gives to it an untidy, unfinished and objectionable appearance as though it were marked copy subject to revision.

The thought has long plagued me that in view of the apparent absence of any word in the English language of "and/or" such a word might well be introduced and defined to convey the precise meaning of "and/or" and thus clear the page of the unnecessary and unsightly virgule which mutilates the typed line.

This subject may be enlarged upon to great length and an extensive review made of numerous past diatribes against the use of "and/or." My purpose here is to bring to attention a suggestion for such consideration as it may merit.

WALTER B. LANG

WASHINGTON, D. C.

WHAT IS SUMMER?

AT this time of year one often reads among scientific notices that the summer solstice occurred at 2:35 P.M. on June 21, or at some other time as the case may have been, and that this event marked the beginning of summer. The local paper enlarges on this news item, leaving out the solstice idea, the editor not being quite sure what the term means, but announcing, in language borrowed from the births column, that summer arrived yesterday afternoon at 2:35. Sometimes the paper says that summer then began "officially," and attributes the determination of the time somewhat vaguely to "the astronomers." Analogous notices appear about December 21, when we are told that winter "came in" at 7 A.M., mildly

or violently as the weather may have determined. The same oracle announces at the equinoxes the "official" beginnings of spring and fall. With this idea, that summer and winter begin at the solstices, and spring and fall at the equinoxes, I absolutely disagree, and, as Chesterton says, with a peculiar ferocity.

Certainly the equinoxes occur about March 21 and September 21, and at those moments the center of the sun is in the plane of the earth's equator. Then the nearest day and night are equal (except for a possible difference too small to be noticed) all over the earth, except at the poles, where the sun may be seen on the horizon. Certainly at the summer solstice we have the longest day of the year, and the sun at noon is higher in the sky than at noon on any other day. Certainly, then, land and sea and air, in our latitudes, are gaining heat most rapidly. But I do not think that summer begins then. June 21 is not the beginning of summer, and no one, by calling it the beginning officially, can make it so.

In the first place, our government can not determine what a common word is to mean. Also there is no "official" whose duty it is to define the names of the seasons, and if there were such an official he could not perform that function. A government astronomer, I suppose, determines the time of the solstice. His work ends when that is done. Writers, editors and calendar makers, wishing to dramatize the event, announce it as the birth of the season, which it is not.

Summer in the Saxon English which we speak by inheritance means the warm season. A dictionary definition is "the hottest or warmest season of the year, including June, July and August in the northern hemisphere." For convenience we make it correspond to whole rather than fractional months. In these latitudes this is reasonable, too, because about July 20, near the middle of these three months, is the hottest time of the year. Further north, of course, the peak of summer is earlier, and it is still more absurd to say that it begins on the longest day. June 24 is Midsummer Day in old English custom, the Feast of St. John the Baptist. You could not tell a farmer that the longest day is the beginning of summer. He would know better. Moreover, so people have written English in poetry and prose. "No price is set on the lavish summer, June may be had by the poorest comer." June, not just June 21 to 30. The period from summer solstice to autumnal equinox is obviously not summer.

It might indeed be convenient to have a term for that period. Such a term should not do violence to nature and the common meaning of useful words. We could call it the third quarter. Then the second quarter would be the time from the vernal equinox to the summer solstice. In this way the first quarter of this year would take in a few days—December 21 to December

31—of last year, and this is awkward. We stupidly begin our year at an arbitrary and unreasonable time. It is as if we passed the solstice without recognizing it, and only began our year when, ten days late, we first noticed the lengthened day. But the quarters are reasonable divisions, marked with astronomical precision, and not to be designated by terms already in use with a different meaning.

I resent the arrogance of those who say that the everyday and historic meaning of a common word is wrong. They are like those small girls who read

Emerson's poem, "The Mountain and the Squirrel," in their fourth readers, and noted that he referred to the squirrel as bun. They announced at once that we were wrong in using bunny to call our pet rabbit. We grant now that the solstice comes on June 21, and we know what the word means. We do not think the solstice marks the advent of summer, and we will not use the word summer to denote the third quarter of the year.

W. W. SLEATOR

UNIVERSITY OF MICHIGAN

SCIENTIFIC BOOKS

SIR JOHN CUNNINGHAM MCLENNAN

Sir John Cunningham McLennan, a Memoir. By H. H. LANGTON. With a chapter on his scientific work by E. F. BURTON. Toronto: University of Toronto Press. 1939. \$2.50.

THE biography of a scientist and a man of great achievements is always welcome and of interest. In this age of the dominance of physical science (a true luxury age for the physicist) in the light of things that have been and perhaps in the light of the days to come, the biography of a man like Sir John is of more than passing interest. Very few of the modern generations of physicists realize what were the conditions in our laboratories in the western hemisphere less than fifty years ago. It is to the sterling leadership, the untiring enterprise and zeal and the scientific idealism of men like Sir John C. McLennan that we owe the present status of research and learning in North America. Starting in an impoverished and lay community with no support and little encouragement Sir John in some thirty years educated this community to a true appreciation of science, built one of the leading physical research laboratories in North America and contributed his share to the fund of knowledge. How this was done and how Sir John himself developed as a physicist is covered in the first chapters of the book, which essentially mark episodes in his life under the titles, "Early Life," "The Department of Physics," "The Alumni Association" and "The Physics Laboratory." The subsequent episodes in this rich and active life are "The War," "Research, Public and Academic Activities after the War" and "The Last Years." In view of the present world situation the relations of science to national defense as illustrated by the activities of Sir John furnish valuable reading. It may be of interest to point out that the magnetic mine so much discussed in recent months was invented and developed as an anti-submarine measure by Sir John. With these mines placed in defensive positions there were gotten one enemy cruiser, three destroyers, three mine sweepers and two submarines. Incidentally, one

of these submarines had successfully negotiated all defenses in the entrance to Scapa Flow only to blow up on Sir John's magnetically controlled mine, thus saving the fleet anchored there serious losses.

An Appendix by Professor E. F. Burton lists the scientific achievements of Sir John. Of these the most valuable were some of his early researches on electrical discharge in gases, the discovery of the earth's penetrating radiation and the isolation by means of an ice ionization chamber on Lake Erie of what is now called the cosmic radiation, the studies on spectra and ionization potentials, the successful construction of the world's second cryogenic laboratory and his discovery of the origin of the green auroral line. In a final Appendix there is a complete list of Sir John's published works.

The biography is historically accurate and well documented. The style is terse but readable, the material is well organized, and the contents are largely factual. No attempt at character analysis is made, although a chapter entitled "Characteristics" describes Sir John in terms of the author's impressions and quotations from his contemporaries.

LEONARD B. LOEB

THE MICROSCOPE

The Microscope. By ROY M. ALLEN. iv + 286 pp. 82 figs. 17 plates. New York: D. Van Nostrand Company, Inc. 1940. \$3.00.

Books dealing solely with the microscope in general are fairly numerous; those that cover the subject and further attempt to describe methods of preparing materials for microscopical examination are less common. The text under review belongs in the latter category despite the statement in the preface that it is "devoted wholly to the theory and manipulation" of the microscope. Actually, however, only 177 of the 286 pages are strictly devoted to microscopes and their operation.

The author, a consulting microscopist and former president of the New York Microscopical Society, ex-

plains in considerable but not belabored detail the optical principles involved in the construction and operation of all the different types of microscopes. The explanations are designed for persons possessed of little knowledge of the optical and mathematical laws involved and are clearly understandable. The information presented has been derived from many sources, and the book thus constitutes a useful and handy reference manual. Instruments of American manufacture are almost exclusively discussed.

In the preface the claim is further made that "the methods and techniques of mounting described represent actual practice originated and developed in the author's own laboratory." The sections devoted to petrological and metallurgical procedures are good, but those dealing with biological materials are somewhat disappointing. The invaluable microtechnique journal, *Stain Technology*, is nowhere mentioned; it is unfortunate that the author could not have utilized it as a source for more modern and dependable methods.

While perusing this book and comparing it with others of a similar nature, the reviewer was struck by the fact that none of these texts has ever achieved a real and satisfactory balance in the treatment of the two phases of the subject. It is a somewhat curious fact that the writers of all such texts seem to be better

grounded in the theory and operation of the microscope than in the principles and procedures of general microtechnique. Discussions of technical methods have always been inadequate, lopsided and oftentimes prejudiced.

The book is excellently printed on a thick white stock. The language is somewhat stilted and occasionally makes difficult reading. A few sentences whose meaning is incomprehensible occur (*e.g.*, the last sentence of the second paragraph on page 179). Although it is a minor point in a book apparently intended primarily for amateur microscopists desiring to know more about their instruments, citation of scientific names and terminology does not consistently follow accepted usage. For example, on page 217 are found "spiragya" and "mycellium." And there is the statement that the staining solution of Heidenhain's iron hematoxylin is "a saturated solution of hematoxylin in water, which requires a week or two to reach saturation" (p. 228).

There is a clearly reproduced color frontispiece and 17 plates of photomicrographs, mostly, as might be expected, of diatoms. Appended is a bibliography of selected references, a glossary of microscopical terms and an index.

DONALD A. JOHANSEN

STANFORD UNIVERSITY

SOCIETIES AND MEETINGS

THE ALABAMA ACADEMY OF SCIENCE

UNDER the auspices of President George D. Palmer, of the School of Chemistry, Metallurgy and Ceramics of the University of Alabama, the Alabama Academy of Science held its seventeenth annual meeting at Birmingham-Southern College, Birmingham, on March 29 and 30, with an attendance of over one hundred and twenty-five members and many visitors. The progressive Alabama Junior Academy of Science held its eighth annual meeting at the same time and place, Artie Belle Pirtle, Sidney Lanier High School, Montgomery, presiding, attended by one hundred and ninety-four delegates from twenty-seven high schools.

The usual executive and business meetings were held on Friday, and the scientific papers were presented in two sessions, on Friday afternoon and Saturday morning, and in four sections, the four vice-presidents serving as section chairmen. These were, respectively, S. R. Damon, Biology and Medical Science, State Department of Health, Montgomery; I. M. Hostetter, Chemistry, Physics and Mathematics, Howard College, Birmingham; A. J. Westland, Geology, Anthropology and Archeology, Spring Hill College, Mobile; and E. D. Emigh, Industry, Economics and Geography,

Weather Bureau, Montgomery. A demonstration on the induction of ovulation by pituitary stimulation, showing the use of this technique in teaching and research, was given in Ramsay Hall by C. M. Pomerat, chairman, Department of Biology, University, as was one on plastics and synthetics by the president. Junior Academy exhibits were held in the same building. All business sessions were held in Munger Hall. A complimentary luncheon was tendered the scientists by the college in the cafeteria, and a tea was given for members of both academies and visitors in the Stockham Building. At the annual banquet, Walter B. Jones, director, Alabama Department of Conservation, Montgomery, served as the very able toastmaster. He later presented to the academy "The Ivory-Billed Woodpecker," a motion picture film, at the joint session in the evening over which he presided. This was held in Munger Auditorium. George R. Stuart, assistant to the president of the college, gave the address of welcome, and the response was made by S. J. Lloyd, dean of the School of Chemistry, Metallurgy and Ceramics, University, and acting state geologist. Dr. Palmer's presidential address was entitled "Scientific Research, the Hope of the South."

One morning and two afternoon field trips for the

academy were arranged by Russell L. Poor, chairman of the Geology Department, Birmingham-Southern College, for Saturday. Much of interest was revealed in the Red Mountain and Shades Mountain regions, in the blast furnaces and coke ovens, as well as in the beautiful residential areas of Mountain Brook and the Country Club.

Reports of special interest at the business session were made by John Xan, Howard College, Birmingham, treasurer; J. H. Coulliette, Birmingham-Southern College, councilor of the American Association for the Advancement of Science, and E. V. Jones, Birmingham-Southern College, editor of the journal. Three new committees functioned for the first time. These were: (1) Committee on Promoting Membership and Activities, Walter B. Jones, *chairman*; the Committee on Research, S. J. Lloyd, *chairman*; and (3) the Committee on Publication, under the chairmanship of E. B. Carmichael, of the Medical School, University, with the editor serving as *ex-officio* member.

The American Association for the Advancement of Science grant-in-aid of research was renewed for another year to J. Allen Tower, Birmingham-Southern College, for continuation of his work on the "Preparation of an Atlas and a Geography of Alabama." The committee was composed of the president-elect, C. M. Farmer, *chairman*, and the four vice-presidents. Two honorary members were elected, namely, Wright A. Gardner, Auburn, founder of the academy, and John Y. Graham, for forty-two years chairman of the department of zoology at the university, who retired last year, now emeritus professor of zoology. The members voted to establish an academy statistician, a permanent director of exhibits and demonstrations and to expand the sections to seven, including Physics and Mathematics in a separate section from Chemistry, and adding one on Geography, Conservation and Allied Subjects and one on the Teaching of Science. James L. Kassner was retained for one more year as

acting permanent counselor of the Junior Academy, to be assisted by two academy members. Sustaining memberships were acted upon favorably, as was a suggestion by the president that steps be taken at the next annual meeting to organize a Southeastern Scientific Society. The academy received an invitation to meet with Howard College in 1942 in connection with the Centennial Celebration of that school. The 1941 meeting will be held at Spring Hill College, Mobile. Following the report of the various committees and the expression of appreciation to the officers and the host college upon the completion of business, the meeting adjourned.

New officers for 1940-1941 were elected as follows: *President*, C. M. Farmer, State Teachers College, Troy; *President-Elect*, Paul D. Bales, Howard College; *Vice-Presidents* and *Section Chairmen*, H. D. Jones, Biology and Medical Science, Alabama Polytechnic Institute, Auburn; Lindsey M. Hobbs, Chemistry, University; David L. DeJarnette, Geology, Anthropology and Archeology, Alabama Museum of Natural History, University; J. Allen Tower, Geography, Conservation and Allied Subjects, Birmingham-Southern College; W. A. Moore, Physics and Mathematics, Birmingham-Southern College, and Claustie E. McTyeire, The Teaching of Science, Hueytown High School, Bessemer. The chairman of Industry and Economics is to be appointed. Miss Winnie McGlamery, Geological Survey, University, was selected as secretary to succeed the present secretary, who has served for five years. J. H. Coulliette, Birmingham-Southern College, councilor of the American Association for the Advancement of Science, was reelected. The terms of office of the treasurer, John Xan, Howard College, and of the editor, E. V. Jones, Birmingham-Southern College, continue for one and two more years, respectively.

SEPTIMA C. SMITH,
—Secretary

SPECIAL ARTICLES

TIME COURSE OF PHOTOSYNTHESIS AND FLUORESCENCE

WHEN a plant is exposed to light after a dark period, photosynthesis (as measured by uptake of CO_2) gradually comes to its full rate during a short interval called the induction period. Changes in intensity of the fluorescence of chlorophyll of the plant during this time have been interpreted¹ in terms of photochemical processes. Experiments are in progress in the Division of Radiation and Organisms of the

Smithsonian Institution for the simultaneous measurement of the rate of uptake of CO_2 and intensity of fluorescence during the induction period.² These measurements confirm the usefulness of fluorescence observations as a tool in the study of photosynthesis.

The rapid spectrographic method of CO_2 measurement previously used³ has been adapted to a constant-flow technique with a rapid time response. The Mazda illumination was limited by filters to $< 6400 \text{ \AA}$ (in-

¹ J. Franck and R. W. Wood, *Jour. Chem. Phys.*, 4: 551, 1936; H. Kautsky and R. Hormuth, *Biochem. Zeits.*, 291: 285, 1937; E. C. Wassink and E. Katz, *Enzymol.*, 5: 145, 1939.

² E. D. McAlister and Jack Myers, *Smithson. Misc. Coll.*, 99: (6), 1, 1940.

³ E. D. McAlister, *Smithson. Misc. Coll.*, 95: (24), 1, 1937; *Jour. Gen. Physiol.*, 22: 613, 1939.

tensity: 60×10^4 ergs/cm.²/sec.). Intensity of fluorescence was measured with a filter-photocell combination responding only to radiation $> 6500 \text{ \AA}$. (Fluorescence of chlorophyll *in vivo* falls in the region between 6500 and 8200 \AA .)

Solid lines on the curves are tracings of original records (upper: intensity of fluorescence; lower: rate of CO_2 -uptake. The dot-dash lines (— · —) represent the probable course of CO_2 -uptake in the plant during the first seconds of illumination, obtained by correcting the recorded curve for the time lag of response of our instruments (6 seconds [wheat] to 15 seconds [*Chlorella*]).

When wheat is suddenly exposed to high light the burst of fluorescence consists of an abrupt initial rise, a slower secondary rise and a decay toward the steady-state, as was previously shown by Franck and Wood.¹ The simultaneously observed rate of CO_2 -uptake follows a course inversely related to fluorescence. In low O_2 (Fig. 1) these curves are almost exact mirror

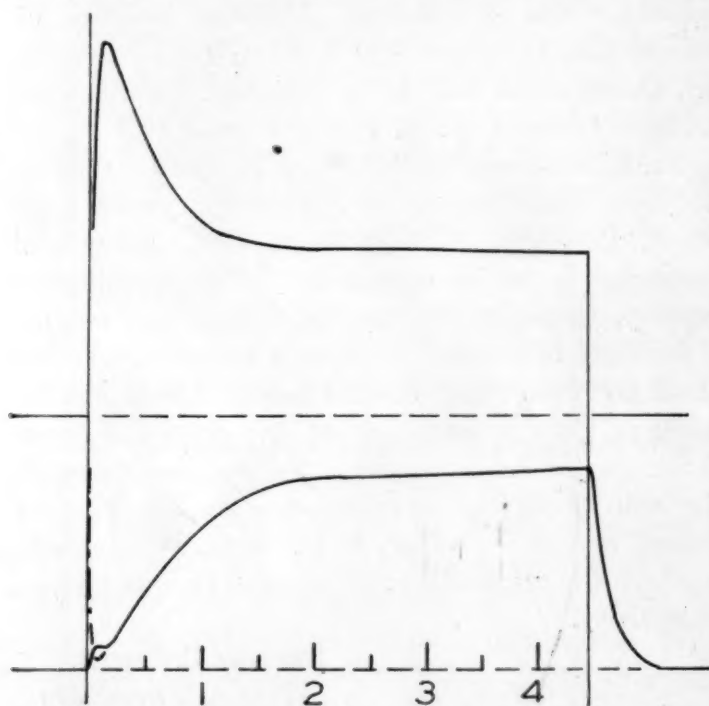


FIG. 1. Induction behavior of wheat in .03 per cent. CO_2 in N_2 . (Ordinates: rate of CO_2 -uptake [lower] and intensity of fluorescence [upper] in relative units; abscissas: time of illumination in minutes).

images as to time. In normal air (Fig. 2) the decay in fluorescence is more rapid, but the induction in CO_2 -uptake is prolonged. For comparison the low O_2 curves of Fig. 1 have been superimposed as broken lines (---). Apparently the induction in normal air is caused by two processes, one of which involves an inverse, the other a direct relation between rate of CO_2 -uptake and intensity of fluorescence. Assuming arbitrarily that the second process does not occur at all in low O_2 , its magnitude in normal air is indicated by the hatched areas. The dependence of the direct relationship on O_2 and the observation of a greater

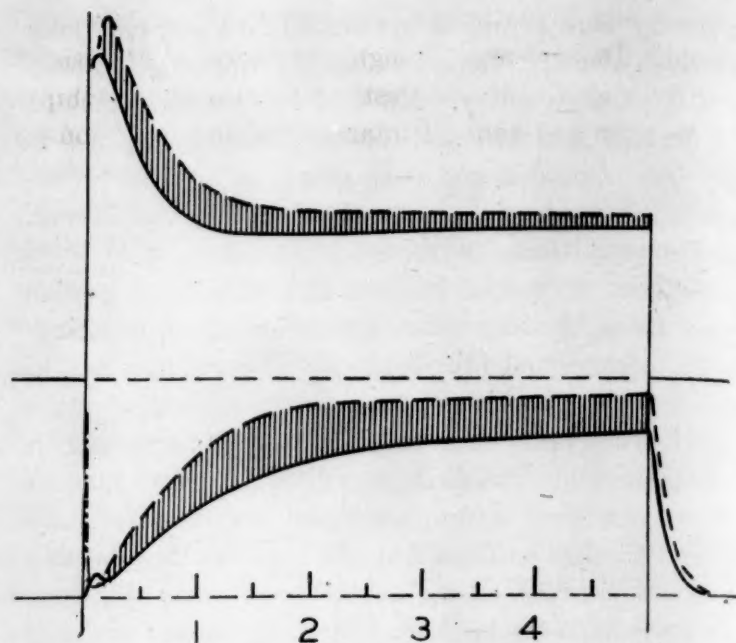


FIG. 2. Induction behavior of wheat in air (solid lines). Curves of Fig. 1 are superimposed as broken lines.

rate of CO_2 -uptake in low O_2 suggests that this process involves a photooxidation.

Under CO_2 concentrations greater than that of normal air the induction in wheat (Fig. 3) is complicated

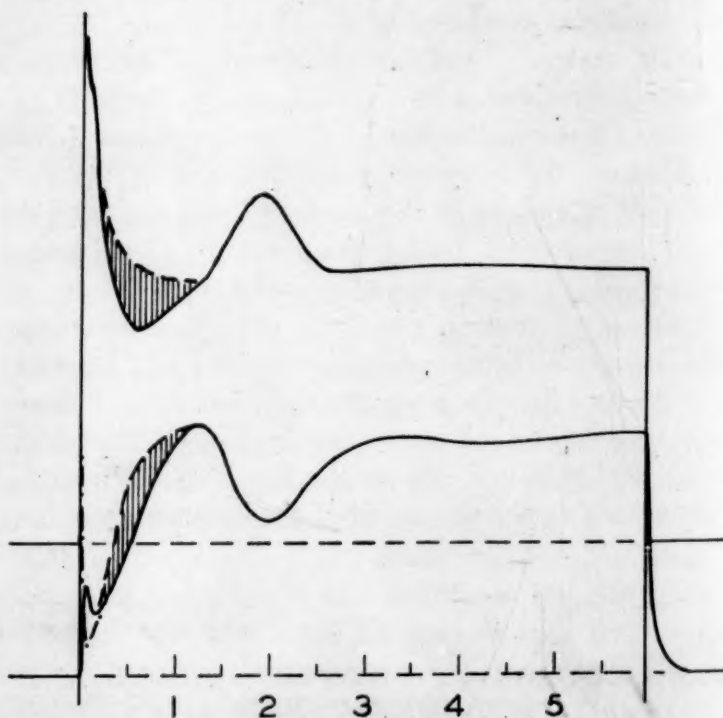


FIG. 3. Induction behavior of wheat in 24 per cent. CO_2 (solid lines). Ordinates for rate of CO_2 -uptake $\frac{1}{2}$ scale of Figs. 1 and 2. Hatched areas represent the minimum extent of a direct fluorescence- CO_2 relation.

by a second maximum in fluorescence. The simultaneous minimum in rate of CO_2 -uptake is clearly inversely related. The broken lines, here arbitrarily drawn in, merely show the possible course in the absence of the second process.

In *Chlorella pyrenoidosa* the induction behavior is greatly influenced by the previous conditions of cul-

ture. Cells grown in 4 per cent. CO_2 show a behavior quite comparable to that of wheat. In the induction shown by cells acclimated to .03 per cent. CO_2 the photooxidation type of reaction predominates to such an extent that minima are produced in both the fluorescence and CO_2 -uptake curves (Fig. 4). The

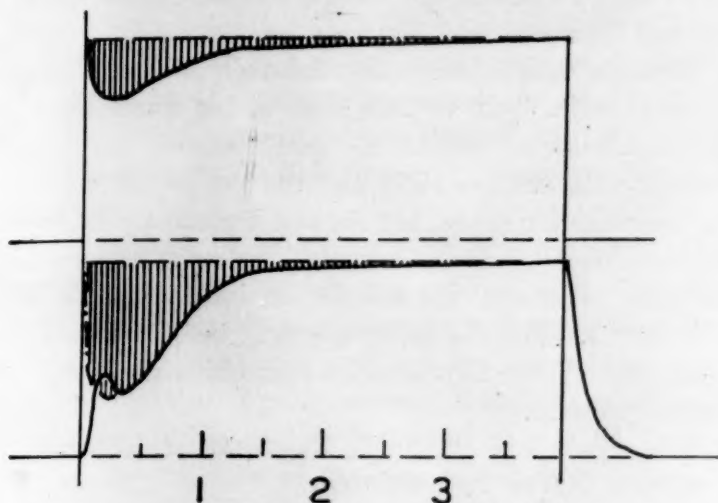


FIG. 4. Induction behavior of *Chlorella* cultured in air. The upper boundaries (broken lines) of the hatched areas are arbitrarily drawn.

arbitrarily drawn broken lines enclose hatched areas representing (as in Fig. 3) what may be considered the minimum extent of the second type of reaction.

The behavior observed in several hundred induction curves, obtained over a wide range of conditions, may be described in terms of two processes. One of these involves an inverse relation between rate of CO_2 -uptake and intensity of fluorescence, the other a direct relation. Further and more quantitative work is being undertaken in order to learn more of the nature of these two processes.

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ETHYLENE INJURY TO CUT FLOWERS IN COLD STORAGE ROOMS

It has been known for some time that even traces of illuminating gas leaking into a greenhouse are detrimental to flowers and plants.^{1,2} Little consideration has been given, however, to the possible presence of gases toxic to cut flowers where they are kept in refrigerators to prolong their period of salability.

Investigations have recently been started at the United States Horticultural Station, Beltsville, Maryland, into the problem of increasing the keeping quality of cut flowers. The flowers so far included in these investigations are carnations, roses, snapdragons, stocks and narcissus. They were all, with

the exception of the narcissus, grown in the Department greenhouses at Beltsville. The latter were grown in outdoor beds. Ample supplies were available in all instances.

Among the factors studied, that of temperature was given considerable attention in an attempt to find optimum conditions when refrigeration alone was considered.

Early in the course of these experiments it was found that ethylene, which is known to be given off by apples and other ripening fruit,^{3,4,5} caused identical injury to cut flowers when they were placed either in sealed containers with ethylene or in storage room with apples or even in rooms close by.

Cheek lots of flowers at 70°, 50° and 36° F. remained in good condition longer than corresponding lots stored in the presence of fruit or ethylene at the same temperature, and with fruit or ethylene, the higher the temperature, the more pronounced was the effect of the gas.

Carnations, roses, snapdragons, narcissus and stocks under these conditions were all adversely affected. The damage to carnations in full bloom was indicated by an incurving of the edges of the petals and they also became discolored and lost their turgor. This effect was typical of the deterioration of carnations commonly known to flower growers as "sleepiness," which may occur both before and after the flowers are cut, and is believed to result from unfavorable environmental conditions. The symptoms of injury observed on cut roses and snapdragons consisted of a discoloration and early dropping of the petals and flowers. Narcissus and stocks reacted by a deterioration of color and shriveling of the flowers.

In general, florists are of the opinion that carnations keep best at a temperature close to 50° F. However, Neff⁶ and the writers have found temperatures between 33° and 36° to be best. The accepted opinion in favor of 50°, rather than the lower temperatures, may have been arrived at as a result of frequent damage to carnations stored in room with ripening apples. Most large cold storage buildings have large quantities of ripening fruit in storage rooms where cut carnations would be stored by florists anticipating peak demands just prior to holidays. Neff reported that his best results were obtained in sealed containers, while the writers used rooms free from the influence of ethylene. Hence in both of these cases the flowers were not damaged by this gas. Most fruits are not generally stored at 50° F. and therefore carnations

³ R. Gane, *Great Britain Dept. Sci. and Ind. Res. Food Invest. Bd.*, 1934: 122-123, 1935.

⁴ E. Hansen and H. Hartman, *Plant Physiol.*, 12: 441-454, 1936.

⁵ J. A. Milbrath, E. Hansen and H. Hartman, *SCIENCE*, 91: 100, 1940.

⁶ M. S. Neff, *Plant Physiol.*, 14: 271-284, 1939.

⁴ National research fellow.

¹ W. Crocker, *Flor. Exc.*, 70: 15 and 54, March 30, 1929.

² P. W. Zimmerman, W. Crocker and A. E. Hitchcock, *Proc. Amer. Soc. Hort. Sci.*, 27: 53-56, 1931.

stored at this temperature would not be so apt to be injured by gases from apples or other fruits. It appears that a temperature of 34° to 36° is best for carnations if they are kept in a room free from ethylene.

In the light of these findings it seems desirable that results of flower storage investigations which might have been influenced by the gases from ripening fruit should be repeated. It is also suggested that the effect of ethylene, whatever its source, on plants and plant parts other than cut flowers should be fully investigated as a factor in storage problems.

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THE RELATION OF INTERNAL SURFACE TO INTERCELLULAR SPACE IN FOLIAGE LEAVES

THE relation of the exposed cellular area of the mesophyll of the foliage leaf to the volume of intercellular space has been of considerable interest because the relation has an important bearing on transpiration rate and on other types of gas exchange. Although the volume of intercellular space was measured by Unger as early as 1854 and has been measured by several investigators since, the relation of internal surface to volume of intercellular space has been largely a matter of conjecture.

In a sample of twenty leaves from four alfalfa plants, the coefficient of correlation (r) between the internal-external surface ratio and the volume of intercellular space per sample area, as shown in Table 1,

TABLE 1
THE COEFFICIENT OF CORRELATION (r) AND ITS LEVEL OF SIGNIFICANCE (P) BETWEEN INTERNAL-EXTERNAL SURFACE RATIO AND VOLUME OF INTERCELLULAR SPACE AND BETWEEN INTERNAL-EXTERNAL SURFACE RATIO AND PERCENTAGE VOLUME OF INTERCELLULAR SPACE OF FOLIAGE LEAVES

Leaf samples	Intercellular space	r	P
Alfalfa	Volume	+0.874	< 0.01
Alfalfa	Percentage volume	+0.629	< 0.01
16 species	Volume	+0.463	< 0.10
16 species	Percentage volume	+0.071	> 0.10

was +0.874; and between the internal-external surface ratio and the percentage volume of intercellular space, the coefficient of correlation was +0.629. Although the correlation coefficient is higher between the internal-external surface ratio and volume of intercellular space than between the internal-external surface ratio and percentage volume of intercellular space, for both values the probability of chance occurrence (P) is less than 0.01, and the correlation coefficients are highly

significant. The relation of the internal-external surface ratio to other mesophyll factors is expressed by the equation

$$R = \frac{t v (1-v) K}{d}$$

where R = the internal-external surface ratio, t = leaf thickness, v = percentage volume of intercellular space, d = cell diameter, and K = a constant.

Random samples of leaves of sixteen different angiosperm species from various parts of the world showed no significant correlation (+0.071) between the internal-external surface ratio and the percentage volume of intercellular space, but showed a moderate positive correlation (+0.463) between the internal-external surface ratio and the volume of intercellular space (Table 1). For the latter value, P lies between 0.10 and 0.05 (Table 1); thus the correlation coefficient is not significant.

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THE ENZYMATIC DEACETYLATION OF HEROIN AND CLOSELY RELATED MORPHINE DERIVATIVES BY BLOOD SERUM

IN preliminary experiments designed to study the effect of morphine on choline esterase activity it was found that morphine salts were precipitated as the alkaloidal base in bicarbonate Ringer solution. An attempt was made to obviate this difficulty by using the more soluble and physiologically more active diacetylmorphine (heroin).¹ An apparent stimulation of the activity of choline esterase led to the measurement of the effect of serum on heroin. It was found that rabbit and human blood sera deacetylate diacetylmorphine.

The measurements of the rates of deacetylation were made with Barcroft manometers at 37.5° C. under an atmosphere of 95 per cent. oxygen and 5 per cent. carbon dioxide. The serum was tipped from a side arm of the manometric flask into a bicarbonate-containing solution of the acetylated morphine, and the carbon dioxide liberated was measured manometrically at desired intervals.

Observations were made using sera from six male albino rabbits, all fed Purina rabbit chow and lettuce. Sera (0.05–0.5 cc) from three of the animals, when added to diacetylmorphine (5.0 mgm), caused a rapid liberation of carbon dioxide corresponding in quantity to 85 per cent. of the theoretical for the hydrolysis of both acetyl groups. The other three animals hydrolyzed the heroin more slowly and liberated carbon dioxide corresponding to 85 per cent. of the theoretical

¹ I am indebted to Dr. L. F. Small, of the National Institute of Health, for furnishing the morphine derivatives and for consultation on their chemistry.

for one acetyl group. Repeated observations over a period of two months always gave identical results for each rabbit.

By substituting monoacetylmorphine for the diacetylmorphine it was found that the animals that were able to remove both acetyls from heroin were able to hydrolyze the 6-carbon acetyl in monoacetylmorphine. Sera from the other three rabbits did not liberate acetic acid from the monoacetyl compound. Therefore, all the rabbits were able to remove the 3-carbon acetyl group, but the sera of only three of the animals hydrolyzed both acetyl groups present in diacetylmorphine.

Further work using diacetyldihydromorphine as the substrate showed that all six rabbits were able to remove acetic acid from this compound, equivalent to approximately 100 per cent. of the theoretical for one acetyl group. Again, however, there was a distinct separation of the rabbits into two groups of three animals on the basis of the rate at which hydrolysis took place. The sera from the three rabbits that were unable to deacetylate monoacetylmorphine hydrolyzed the dihydrodiacetylmorphine at a much slower rate.

At this point it was predicted that the diacetyldihydromorphine was hydrolyzed at the 3-carbon, and subsequent determinations with monoacetyldihydromorphine as substrate proved this to be true, since none of the animals were able to deacetylate this compound.

Preliminary experiments have shown that human blood serum is able to deacetylate heroin, but at a distinctly slower rate than any of the sera from the rabbits so far investigated.

Physostigmine inhibits the activity of the enzyme

responsible for the deacetylation of the acetylated morphine derivatives. This indicates the possibility that the enzyme might be choline esterase. However, all six rabbit sera have almost identical capacity for hydrolyzing acetylcholine. Also, the human sera so far investigated have much higher concentration of choline esterase than the rabbit sera and at the same time a lesser capacity for the hydrolysis of heroin.

From these results it seems probable that, in the rabbit at least, the difference in potency of heroin and morphine might be fundamentally due to physical factors such as solubility rather than chemical structure, since it appears likely that the animal, in the final analysis, is reacting to morphine, whichever of the two alkaloids is injected. The same applies to monoacetylmorphine.

It would be of considerable interest to determine whether the esterase attacking the acetylated morphines is present in the tissues, especially the central nervous system and to extend the investigation to include other species of animals. It is also possible that certain other morphine derivatives, after entering the body, are converted into morphine. If so, this would be of considerable aid in clarifying some of the similarities and differences in physiological activity that have been found among the chemical compounds related to morphine. The investigation of these possibilities and others not so obvious is now planned.

This is a preliminary report and will be published in detail elsewhere.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A TECHNIQUE FOR THE INTRAVENOUS INOCULATION OF CHICK EMBRYOS

In the course of experimentation on the growth of various viruses in chick embryos, the need of a simple technique for the inoculation of embryos directly into the blood stream became very evident.

The method of Goodpasture, *et al.*,¹ consisting in removal of that portion of the shell over a vein or the air sac, application of mineral oil to the membrane to render it transparent and then picking up the veins for injection and subsequent searing of these veins, was tried. While some success by this method may be noted, it has several disadvantages, notably difficulty encountered in injection due to the mobility of the vein during inoculation.

Secondly, there was considerable hemorrhage on withdrawal of the needle even after cauterization of the vein at two points before withdrawing the needle.

A third difficulty is that the removal of the shell cap over the air sac exposes a large area and subsequent maintenance of sterile conditions is difficult even after sealing with Scotch tape.

Accordingly, the following procedure was developed at the laboratories of the Pathological Division of the Bureau of Animal Industry.

Ten- to eleven-day-old embryos were found to be the youngest which could be easily injected routinely. The eggs are candled to locate a vein of the terminal sinus which is fairly straight and which lies embedded in the chorio-allantoic membrane.

This section of vein is then marked on the shell for about 1-1.5 cm, and an arrow indicating direction of blood flow is marked nearby.

¹ Polk, Buddingh and Goodpasture, *Am. Jour. Path.*, 14: 1, January, 1938.

Injection of the material in the direction of the blood flow is important, as hemorrhage usually results if the needle is inserted against the flow.

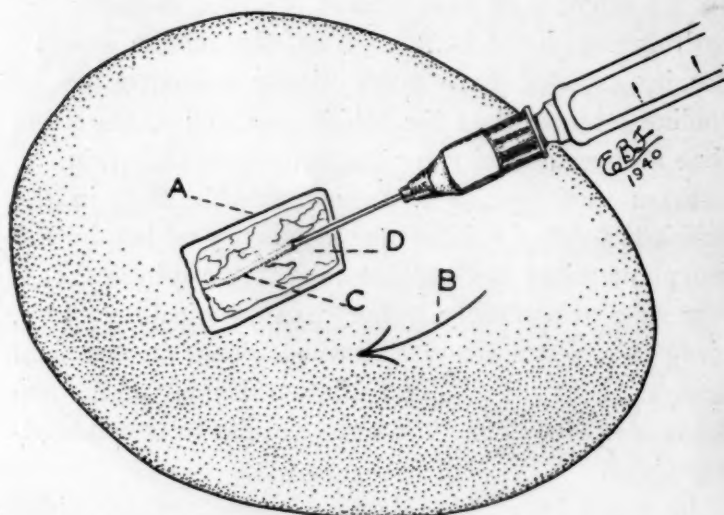


FIG. 1. A. Section of shell removed leaving shell membranes intact. B. Arrow showing direction of blood flow. C. Vein. D. Shell membranes made transparent by oil and adhering chorio-allantoic membrane.

A square of approximately 1 cm is then cut through the shell to the inner shell membrane around the portion of the vein marked on the shell. This is done by means of a high-speed grinder such as the Handee or Moto-tool. If the grinder is clamped to a stand and the egg manipulated, the cutting of the shell is facilitated as more accurate pressure may be applied. Care must be taken not to cut through the outer and inner shell membranes, as the chorio-allantoic membrane will then usually pull away from the outer shell membranes and it will be impossible to expose the vein. The cut section of shell is then lifted away by inserting any fine-pointed instrument in the cut and lifting.

A drop of light, sterile mineral oil is then placed on the membrane, which immediately becomes transparent, exposing the vein, and the egg is ready for injection.

It is advisable to use a $\frac{1}{4}$ cc tuberculin syringe with a 25-27 gauge needle, and the angle of insertion should be as acute as possible using the posterior edge of the cut as a support, while the bevel of the needle is held uppermost. Withdrawal should be extremely slow and caution exercised to prevent possibility of hemorrhage. In this connection it was found that the probability of hemorrhage with veins larger than the diameter of the needle is greater than with those slightly smaller, hence it is preferable to pick out, if possible, a portion of a vein of medium size.

After the needle is withdrawn, the egg is sealed with a 6 per cent. solution of paralodion in ether.

In bleeding the embryo, the same procedure is followed, with the exception that the needle is inserted against the direction of flow.

Quarter cc amounts have been bled from embryos without apparent damage and quantities of blood up to 0.1 cc injected with survival. Allantoic fluid, however, has proved fatal in a few minutes when injected intravenously in 0.01 cc quantities, producing tremendous hemorrhage in the embryo proper.

In conclusion, there have been 32 passages to date from egg to egg in series by this method, while mortality rate due to hemorrhage in faulty manipulation has been approximately 30 per cent., but there is no reason why this can not be considerably reduced with improved technique.

ERVIN A. EICHORN

U. S. DEPARTMENT OF AGRICULTURE

MOUNTING EMBRYOLOGICAL MUSEUM SPECIMENS WITH GLASS WOOL

By using the following technique a practically transparent, as well as artistic, suspension of specimens may be obtained.

First, pour mounting medium in jar (10 per cent. formalin, or glycerin, etc.). Second, place specimen in jar of medium and encircle it with the least possible amount of loosely meshed, fine, glass wool, enough to hold the object suspended and freely oriented to present the most satisfactory picture.

ETHEL W. VENNING

UNIVERSITY OF VIRGINIA

BOOKS RECEIVED

- ADDICKS, LAWRENCE, Editor. *Silver in Industry*. Pp. vii + 636. Illustrated. Reinhold. \$10.00.
- CLAUSEN, JENS, DAVID D. KECK and WILLIAM M. HIESEY. *Experimental Studies on the Nature of Species: I, Effect of Varied Environments on Western North American Plants*. Pp. vi + 452. 155 figures. Carnegie Institution of Washington. \$3.50.
- DE HAAS, J. H. and IR. O. MEULEMANS. *Melk in Het Bijzonder Als Zuigelingenvoedsel*. Pp. 104. Drukkerij Smits, Batavia.
- DE VRIES, LOUIS. *French-English Science Dictionary; For Students in Agricultural, Biological and Physical Sciences*. Pp. viii + 546. McGraw-Hill. \$3.50.
- HOBGEN, LANCELOT. *Principles of Animal Biology*. Pp. 415. 147 figures. Norton. \$3.75.
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- NEEDHAM, JAMES G. *Introducing Insects; For Beginners*. Pp. v + 129. Illustrated. The Jaques Cattell Press, Lancaster, Pa. \$1.50.
- NETTLETON, L. L. *Geophysical Prospecting for Oil*. Pp. xi + 444. 177 figures. McGraw-Hill. \$5.00.
- OSBORN, FREDERICK. *Preface to Eugenics*. Pp. xi + 312. Harper. \$2.75.
- RICHARDSON, E. G. *Sound*. Pp. vii + 339. 118 figures. Longmans, Green. \$5.25.
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- WINDLE, WILLIAM F. *Physiology of the Fetus; Origin and Extent of Function in Prenatal Life*. Pp. xiii + 249. 70 figures. Saunders. \$4.50.